THE IMPERIAL PIPE LINE COMPANY LIMITED

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COLD-WEATHER PIPE LINING

John E. Lyle

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by

John E. Lyle

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The construction and operation of pipelines during the severe winter weather of Western Canada present unique problems. Some of these variations from normal pipeline practices are discussed and illustrated. Through the hard school of experience, pipe lining in cold weather has been found to be expensive and often discouraging both to contractor and owner.

Ordinarily, pipe lines are constructed in Western Canada during the summer months when weather conditions are favorable. Occasionally, however, it is found necessary to build them during the winter, and when this happens, special methods must be adopted to protect men and equipment to accomplish even the ordinary functions of pipe-line construction and operation. This paper on cold-weather pipe lining has therefore been prepared to present some of the difficulties encountered and to illustrate methods of overcoming them. It is hoped that an appreciation of the problems of cold-weather pipe lining will show that though they are not insurmountable, they are certainly costly and sometimes disheartening. Courage, patience and perseverance are required by those who would build and operate pipe lines under the winter-weather conditions normally experienced on the Canadian prairies.

WINTER WEATHER

The oil-producing areas of Western Canada, being scattered across the Great Central Plain of North American and lying in the pathway of the prevailing westerly winds, have a rather dry continental climate. Annual precipitation amounts to about 18 in. of moisture, counting both summer rain and winter snow. Winter conditions begin during November and end in March, a period of 4 to 5 months. During this time the temperatures range from just around freezing to 40 deg F below zero, so that snow falling in early Winter usually remains until Spring. A large percentage of the short days are clear, calm, and cold. The worst winter condition is known as a blizzard, in which 20 to 30-mph winds drive falling snow with blinding force to smother roads and equipment under great hard-packed drifts. During a blizzard, construction and operation of pipe lines cease, for then all outdoor work and transportation are at a standstill. However, bright, dry weather at -10 F is not unpleasant and tempts those trying to construct things in the open to proceed. Under such conditions pipe lines can be built and operated.

METHODS

There are two methods of building pipe lines in Winter. The first is a split job whereby the line is welded and left on the surface of the frozen ground for operating until the following Summer, when ditching, wrapping and clean-up can be done in the normal manner. Construction of a line by this method costs approximately one third more than summer construction. It is a fast and comparatively easy method of supplying pipe-line service; it is always used if the crude being moved can be handled when very cold. Occasionally, oil with a high-pour point is found which cannot be pumped through a surface line in winter. Then, if economic justification can be found, the second method of building a line is used; that is, a complete pipe-line job, including wrapping and burying, is done in the cold weather. This is slower and much more difficult and costly than the split-job method. It requires a sustained effort and considerable ingenuity on the part of the contractor, while the owner must be prepared to pay out from 1-1/2 to 1-3/4 times as much for the line, as he would for the same one built in summer.

PROBLEMS

The first problem of cold-weather pipe lining arises with manpower. Suitable living accommodation is very difficult to obtain and

winter camps for men are expensive and often uncomfortable. Clothing must be warm but not so heavy as to hamper movements or cause excessive perspiration during work. On very cold days the men become more concerned with keeping themselves warm than with doing their work, which makes it difficult to accomplish much. This low working efficiency of men in cold weather, together with the short working days, due to the few hours of daylight available, seriously increases the cost of doing pipe line work.

SNOW CLEARING

When the crews are established and ready to begin actual construction they are immediately faced with the removal of quantities of snow. This is a recurring problem which will hamper their work all through the job. Snow can be removed quite readily from access roads and rights-of-way by means of bulldozers, but when this operation must be repeated every other day or so, it becomes a costly task indeed. Sometimes it has to be done for each phase of the work such as for pipe stringing, welding, ditching, wrapping and, if it is very bad, for backfilling as well. Snow must be removed from joints of pipe before they are welded together in order to keep the line free of ice. If much snow drifts into an open ditch it must be cleaned out before the pipe can be lowered in. Experience has shown that the most satisfactory method of clearing snow from a ditch is by hand. A gang of men with shovels have been known to do it faster and better than any of several machines tried out. Any organization of work which will eliminate repetitions of snow removal is worth trying. One contractor found it profitable to reduce the length of his pipe-line sections to just what his spread could finish in one day. Thus, by keeping all men and machines bunched closely together, he could complete from 2000 to 3000 feet of line each day with only one snow removal. Ploughing snow with a bulldozer in a settled area will wreck fences, hedgerows, and trees in shelter belts, all of which must be repaired or paid for the following Spring. Drifting snow is one of the chief obstacles to cold-weather pipe lining.

WELDING

To do acceptable pipe-line welding in winter weather, special precautions must be taken. The welder himself must be protected by adequate clothes, such as a flying suit and flying boots, and by shelters, so that he can concentrate on his exacting work without worrying about anything else. Welding in temperatures lower than +10 F is made difficult by the accelerated cooling rate of the steel, which is liable to develop cracks commonly known as shrinkage cracks in such weather. To guard against this, the rate of cooling can be reduced in several ways:

1 By preheating the ends of the pipes to be welded.

2 By having the hot pass, or second welding bead, put in immediately after the stringer bead.

3 By applying a filler bead and the finishing bead before the weld has cooled to air temperature.

4 By quickly wrapping the completed weld with a turn or two of asbestos felt paper.

5 By placing windboards or canvas shelters on the windward side of the welders doing the operation.

With care, successful welding can be done in this manner at -20 F, though if possible, it is much better to stop all field welding in any temperatures below zero. It is imperative to have x-ray inspection for the detection of cracks in welding done on pipe lines in cold weather and it is well to have 50 per cent or more of the work x-rayed. All these precautions add considerably to costs, and help make cold weather pipe lining an expensive business.

DITCHING

The ground begins freezing from the surface downward in November and frost continues to penetrate until the end of February, when a maximum depth of from 3 to 6 ft is reached, depending on the condition of the soil. Thawing, also from the surface downward, begins in March and is fairly well complete in late May or early June. An ordinary wheel-type ditcher can cut approximately 12 in. of frozen earth so that ditching for pipe lines in the usual manner can be carried on successfully from early May until late November.

To dig trenches in ground with more than foot or frost, some device must be used to help the ditching machine. A ripper, consisting of a single, very strong steel tooth mounted behind a D-6 Caterpillar tractor, will break up 15 to 18 in. of frost, and permit a ditcher to work. The ripper tears up such large piece

frozen ground that a backhoe or bulldozer st be used to clear a path for the ditching chine. The huge lumps of frozen earth make ckfilling very difficult. A second and more tisfactory way of helping the ditcher is by awing the ground along the ditch line by rning straw and slack coal on it for a period 3 to 4 days. Burning a ditch costs close to ¢ per lineal foot, if the straw and coal are ailable in the district. It has the advantage making backfilling easy because the spoil nk is then in a crumbly state. Either way, tching in frozen ground is very slow and stly.

APPING

A cleaning, priming, and wrapping job on ipe line in cold weather using a coal-tar amel is inferior in quality to a similar b done in summer weather. Some factors ntributing to this condition are:

1 Frost on the pipe.

2 Frost clinging to or freezing into the rimer.

3 The very rapid cooling of the enamel ith consequent cracking or checking with any ovement of the pipe.

4 Damage to the coating when lowering the ipe into a frozen ditch.

Each of these factors must receive attention f an acceptable wrap job is to be obtained.

The best that can be done is on a com- aratively short pipe-line section in one wift operation. Frost can be removed by making wo passes with the cleaning machine, the first f these without primer. By running the wrapping achine about 50 ft behind the cleaning machine n its second pass, and preventing the freshly rimed pipe from being lowered to the ground on kids, a passable wrap job can be obtained. fter wrapping, it is best to cradle the pipe traight into a snow-padded ditch in order to rotect the coating. In cold weather no slack oops are required since the steel is con- racted already more than it will ever be in ne line. Therefore, backfilling should follow losely behind the wrapping to complete the peration. Examination and re-jeeping, after pring thaw, of a number of small sections of ipe line coated and buried in this manner at 5 deg below zero, indicated that a fairly atisfactory job had been done. An acceptable ond, and not too many holidays in the coating ere found. At the same time it was felt that such a job was not as good as could have been done in summer.

OPERATING PROBLEMS

Some of the problems of operating a crude oil pipe line gathering system in cold weather include motor start-up, pump suction and valve troubles, heating and circulating of high pour point crude in booster stations, and the scheduling of production to keep oil moving at all times through the main lines. These will be discussed briefly in turn.

Motor Start-up

Though electric-driven pumps are the most convenient kind to use in a cold climate, electric power is not always available. There is still a large number of gas-driven motors in operation and starting such motors at 30 deg below zero can be a real problem. Two ideas have been developed which solve most of the difficulties of cold-weather start-up: (1) Gas-fired heaters, similar to domestic water heaters, have been used to warm the anti-freeze in the motor blocks, and (2) a convenient electric plug-in mounted on the front bumper of the pumpman's vehicle makes it easy to use a warm fully-charged battery on a self-starter. These ideas have been very successful during the last 5 years.

Pump Suctions

Suction lines in field batteries which do not produce enough crude to maintain continuous pumping become plugged with congealed oil and wax during the time tanks are being filled and pumps are idle. A small quantity of varsol mixed with the crude lowers its pour-point and makes it pumpable. By arranging a by-pass from the pump discharge to the suction and mixing about 1 qt of varsol in the crude oil left in the pump bleed-off sump barrel, the pipe-line pump can be used to force the con- gealed oil back into the tank and clear the way for fresh crude to reach the pump.

Pump Valves

Pump valves will not operate if the crude is congealed or if they become waxed up too much. To correct this situation, a fluid end heater for a field pump has been developed. A 200-watt length of lead-covered soil cable is wrapped around the case of the pump and enclosed in a neat metal box insulated with fiberglas. At a cost of $8.00 per month for electricity,

each pump can be kept warm enough for satisfactory operation at any time.

Heating and Recirculating

Crude arriving at tankage in a booster station in cold weather must be kept pumpable. This is done by using a large capacity line heater of conventional design, on the stream just before it passes into the tank. Storage oil is recirculated back through the heater before pumping it out of the station. Though there is nothing new about heating and recirculating crude, it is not ordinarily done by pipe-line operators and adds considerably to operating costs.

Scheduling Production

In cold weather if high pour-point crude can be kept moving through a pipe line, there is little chance of it congealing into a semi-solid mass which can block further pumping. By obtaining the co-operation of the oil producers, schedules of production can be worked out to insure a quantity of oil for pumping at all times. This can be complicated and requires careful planning and a large amount of goodwill between producers and pipe-liners.

SUMMARY AND CONCLUSIONS

In conclusion, it might be said that almost anything can be done for a price. To construct pipe lines in cold weather, a contractor must be resolute and resourceful in order to overcome such difficulties as repeated snow removals, trenching in frozen ground, and adjustments of working methods to suit varying conditions; while an owner must have a strong justification for the project, great patience with delays and setbacks, and he must be prepared to pay the high costs of winter construction. The operation of pipe lines in Winter is often rough work but it is not nearly so formidable as constructing them, for the most difficult operating problems have usually been considered in the design of a pipe-line system.